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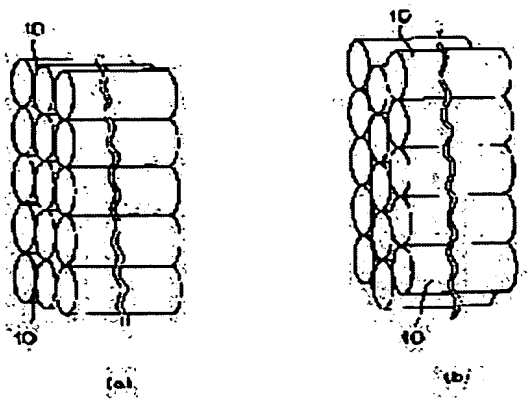
(54) STEREOSCOPIC IMAGE DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To realize a stereoscopic image device for picking up a stereoscopic image, optically transmitting the image and displaying the transmitted image.

SOLUTION: This stereoscopic image device comprises an aggregate of plural optical fibers 10 having equal length and lens action. The length of plural optical fibers 10 is integer times of one period of an optical path in the fibers 10 and the 1st end faces of plural optical fibers 10 are aligned on the same plane to form the 1st end face of the optical fiber aggregate, the 2nd end faces of plural optical fibers 10 are aligned on the same plane to form the 2nd end face of the aggregate, and the arrangement of the end faces of plural optical fibers 10 on the 1st end face of the aggregate is equal to that on the 2nd end face of the aggregate. In the constitution, an image is picked up on the 1st end face side of the optical fiber aggregate, the picked-up image is transmitted to the 2nd end face of the aggregate and displayed on the 2nd end face side of the aggregate.

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CLAIMS

[Claim(s)]

[Claim 1] Die length consists of the aggregate of two or more optical fibers which have a lens operation equally, respectively. The die length of two or more of said optical fibers is the integral multiple of one period of the optical path in an optical fiber. Each 1st end face of two or more of said optical fibers is on the same flat surface. The 1st end face of said aggregate Nothing, Each 2nd end face of two or more of said optical fibers is on the same flat surface. The 2nd end face of said aggregate Nothing, The arrangement in the 1st end face of said aggregate of the end face of two or more of said optical fibers and the arrangement in the 2nd end face are equal. Solid image equipment characterized by what it picturizes to a 1st [of said aggregate] end-face side, and the picturized image is transmitted to the 2nd end face of said aggregate, and is displayed on a 2nd [of said aggregate] end-face side.

[Claim 2] Solid image equipment according to claim 1 with which said two or more optical fibers are characterized by a refractive index having the refractive-index distribution which becomes large toward a core from a periphery, respectively.

[Claim 3] Solid image equipment according to claim 2 characterized by being the property which radial refractive-index distribution of two or more of said optical fibers can approximate in a square property.

[Claim 4] Solid image equipment given in one term of claims 1-3 characterized by inserting the optical system which reduces, expands or rotates the image by which image formation was carried out in the field which carries out image formation within each optical fiber when parallel light carries out incidence to said two or more optical fibers.

[Claim 5] Solid image equipment given in one term of claims 1-4 characterized by inserting optical multiplication equipment in the field which carries out image formation within each optical fiber when parallel light carries out incidence to said two or more optical fibers.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] this invention -- solid image equipment -- being related -- especially -- being the so-called -- integral photography the (IP) technique was applied -- it is optically related with the solid image equipment which can transmit a solid image.

[0002]

[Description of the Prior Art] As for the conventional equipment for transmitting a solid image, what transmits independently the image for left eyes with binocular parallax and the image for right eyes using a transmission system like a coaxial cable or an optical fiber, respectively was common. Moreover, also in the multi-eye solid method, it was common to have transmitted the image corresponding to each eye independently. Furthermore, in these transmissions, it was common for the image corresponding to each eye to have been once changed into an electrical signal, and to have transmitted with an electrical signal, or to have changed and transmitted to a lightwave signal again from an electrical signal.

[0003] the convex lens group or pinhole group arranged by the plane was used as one of the solid image methods seen freely from the view of arbitration on the other hand -- being the so-called -- integral photography (IP) is known. This method is explained below.

[0004] first, two or more convex lenses 21 arranged on the same flat surface as shown in drawing 8 , and 22, ..., 2n from -- the photographic subject 1 which placed the photographic film 3 behind [becoming] the lens group 2, and was placed before the lens group 2 is photoed. In a photographic film 3, they are each convex lens 21 and 22, ..., 2n. The image 31 of a photographic subject 1, and 32, ..., 3n Image formation is carried out and a photograph is taken. Next, a stereoscopic model can be seen, when it arranges in the same location as the film when taking the photograph taken and developed to the lens group 2 and the image on a photograph is seen from the front of the lens group 2 in this condition.

[0005] Here, there is a problem which should be solved in addition also in the method which picturizes directly the lens group mentioned above. Signs that it saw near the lens group in this method from a top or width to drawing 9 are shown. Image formation of the image of the object point O1 is carried out to the location of P1 by convex lens [of a lens group] L (n). In this case, in the image formation side, it enters in the

diameter which is the image pick-up field of convex lens [of a lens group] L (n). On the other hand, image formation of the image of the object point O2 is carried out to the location of P2 by the same convex lens L (n). In this case, image formation is carried out into the diameter of adjoining convex lens L (n+1). Furthermore, image formation is carried out to the location of P3 by convex lens L (n+1), the image of the object point O2 and the optical image of the object point O3 lap, and the object point O3 produces fault, in order to interfere.

[0006] Furthermore, a false image with reverse irregularity will be in sight by the above-mentioned IP method. Then, in order that a concave thing may return the stereoscopic model reversed by convex to a normal stereoscopic model, it is supposed separately that a certain means is required.

[0007]

[Problem(s) to be Solved by the Invention] With the equipment which transmits the signal corresponding to each conventional eye independently, only in the number according to the number of eyes, a transmission system cannot but be needed and a scale cannot but become large. Moreover, in the case of the method which changes the image corresponding to each eye into an electrical signal once, a transmission system becomes complicated.

[0008] On the other hand, the IP method is the technique invented for the purpose of the record reclaiming process of the solid image which used the photographic plate originally, if the optical transmission line decided by distance from the principal plane of the convex lens formed in the shape of an array to a focal plane can be lengthened, a stereoscopic model normal at a televising side cannot be reproduced, but a conversion means is as [of what can transmit solid information / this] needed separately. Moreover, expansion and contraction cannot do magnitude of a stereoscopic model, either and a transmission system cannot be crooked freely, either. Furthermore, there is difficulty of manufacturing the two dimensional array which makes the convex lens which is a spherical lens arrange with a sufficient precision.

[0009] This invention solves such a conventional problem and aims at realizing optically the solid image equipment which can be transmitted for a solid image.

[0010]

[Means for Solving the Problem] In order to attain the purpose mentioned above, the solid image equipment by this invention Die length consists of the aggregate of two or more optical fibers which have a lens operation equally, respectively. The die length of two or more of said optical fibers is the integral multiple of one period of the optical path in an optical fiber. Each 1st end face of two or more of said optical fibers is on the same flat surface. The 1st end face of said aggregate Nothing, Each 2nd end face

of two or more of said optical fibers is on the same flat surface. The 2nd end face of said aggregate Nothing, The arrangement in the 1st end face of said aggregate of the end face of two or more of said optical fibers and the arrangement in the 2nd end face are equal. It is characterized by what it picturizes to a 1st [of said aggregate] end-face side, and the picturized image is transmitted to the 2nd end face of said aggregate, and is displayed on a 2nd [of said aggregate] end-face side.

[0011] It is desirable that said two or more optical fibers are the properties which it is desirable to have the refractive-index distribution to which a refractive index becomes large, and radial refractive-index distribution of two or more of said optical fibers can approximate in a square property especially toward the core from a periphery, respectively.

[0012] Optical multiplication equipment can be inserted in the field which carries out image formation within each optical fiber when the optical system which reduces, expands or rotates the image by which image formation was carried out can be inserted in the field which carries out image formation within each optical fiber when parallel light carries out incidence to said two or more optical fibers or parallel light carries out incidence to said two or more optical fibers.

[0013]

[Embodiment of the Invention] Two or more optical fibers 10 which have a lens operation and have the same die length are made for each die length to become radial with the integral multiple of one period of an optical path by having uneven refractive-index distribution like a square property, in this invention, as shown in drawing 1 , respectively. And such two or more optical fibers 10 are arranged as are shown in drawing 2 (a) or (b), and the end face in the both ends of each optical fiber is on 1 flat surface. It is made for the two-dimensional array in the both-ends side of each optical fiber to become the same in that case. Thus, the solid image picturized by the end side by two or more things to do for optical-fiber arrangement can be transmitted to the other end with light, and it can display by the other end side.

[0014] It is [0015] as an example which becomes small as the refractive index of glass fiber is high in a radial core and goes to a periphery.

[Equation 1]

$$n = n_0 \operatorname{sech}(\sqrt{A}\,r) = n_0\left\{1 - \frac{A}{2}r^2 + \frac{5}{6}\left(\frac{A}{2}\right)^2 r^4 - \cdots\right\}$$

$$\fallingdotseq n_0 \cdot \left(1 - \frac{A}{2}r^2\right) \qquad (1)$$

n：半径ｒにおける屈折率

n_0：中心における屈折率

A：光ファイバの材料によって定まる定数

ｒ：半径

[0016] When light carries out incidence to the optical fiber which comes out and has the property shown, since the refractive index is as high as a core, as shown in drawing 3 , light moves in a zigzag direction, carries out image formation in respect of a certain specification, and has a lens operation. It will be devised by D.MARCUSE etc. in 1964 and this principle is The Bell System Technical Journal for details.; July and 1964 It is indicated. The conditions from which this image formation location serves as an outgoing radiation end face are [0017].

[Equation 2]

$$\theta = \sqrt{A}Z_0 = \frac{\pi}{2}, \frac{3\pi}{2}, \cdots\cdots, \frac{\pi}{2}(2m+1) \qquad (2)$$

m：０以上の整数

Z_0：光ファイバー長

[0018] It comes out. And the light to which theta came out of the optical fiber between pi and 2pi from the photographic subject which exist far away is passing along this optical fiber, and carries out image formation of the erect image (refer to drawing 3). Optical-fiber length is set up so that may replace with the two dimensional array of a spherical lens, the optical fiber which has the refractive-index distribution with an uneven square property etc. in radial may be arranged so that the end face may become two-dimensional array, the optical image which carries out image formation may turn into an erect image by the technique proposed by this invention

person who enabled the image pick-up and the display of the dynamic image by the IP method at Japanese Patent Application No. No. 307763 [eight to] and an image formation location may become the outgoing radiation end face of an optical fiber as mentioned above. That is, as shown in drawing 4 , it is the optical-fiber length Z0. [0019]

[Equation 3]

$$\theta = \sqrt{A}Z_0 = \frac{3\pi}{2} \qquad (3)$$

[0020] It is considering as ******** die length.

[0021] By doing in this way, image formation of the distant photographic subject is fully mostly carried out to an optical-fiber outgoing radiation end face. Therefore, the magnitude of this optical image by which image formation was carried out does not become more than the magnitude of an outgoing radiation end face. Therefore, it does not interfere in the optical image by which has arranged this optical fiber like drawing 2 so that an end face may be arranged in the shape of two-dimensional, and image formation was carried out to this optical-fiber end face also as a lens group mutually, but it becomes that the optical obstruction substantially established between lenses with the same effectiveness. Moreover, since the erect image is obtained in the optical-fiber end face, it is a display side and not the false image that carried out the concavo-convex inversion but a right stereoscopic model can be reproduced by using a convex lens.

[0022] By Japanese Patent Application No. No. 307763 [eight to] mentioned above, the optical-fiber length by the side of an image pick-up is made into the die length which fills (3) types, and it is shown that the lens group for playback can be constituted with the usual convex lens. When it constitutes the convex lens by the side of this playback from an optical fiber like an image pick-up side, it is the optical-fiber length Z0. [0023]

[Equation 4]

$$\theta = \sqrt{A}Z_0 = \frac{\pi}{2} \qquad (4)$$

[0024] It becomes the die length to satisfy. That is, it is an image pick-up side and is a theta=3pi/2, and display side, and by being referred to as theta=pi/2, a stereoscopic model can be picturized and optical-fiber length can be displayed. Moreover, it is an image pick-up side and is a theta=pi/2, and display side, and a stereoscopic model can be similarly picturized as 3pi/2, and optical-fiber length can be displayed. These are

indicated by Japanese Patent Application No. No. 307763 [eight to]. However, although the image pick-up and the display are separated and transmission equipment is required of invention indicated by Japanese Patent Application No. No. 307763 [eight to] between them, unification of an image pick-up, transmission, and a display is not indicated by Japanese Patent Application No. No. 307763 [eight to].

[0025] This invention unifies the image pick-up section, a transmission part, and a display using an optical fiber.

[0026]

[Example] Drawing 2 is what, and showed it, as each end face is on 1 flat surface, a laminating is aligned and carried out and it arranges two or more optical fibers 10, and it is taken as the aggregate. [what] [one example of this invention] [**] [type] The die length of two or more optical fibers is equal, and as shown in drawing 1 , when all optical fibers have uneven refractive-index distribution in radial, it has a lens operation and refractive-index distribution of all optical fibers is still more nearly equal. The die length Z0 of an optical fiber [0027]

[Equation 5]

$$Z_0 = \frac{\theta}{\sqrt{A}} = \frac{1}{\sqrt{A}} 2 \quad (m+1)\ \pi \qquad (5)$$

[0028] It is ******** die length. This optical fiber can be arranged as shown in drawing 2 , and a solid image can be guessed a direct view to the outgoing radiation end-face side of an optical fiber. In the case of m= 0, it becomes the same conditions as the time of being an image pick-up side, being a theta=3pi/2, and display side, being a theta=pi / 2, or image pick-up side, being a theta=pi/2, and display side, and setting to theta=3pi/2 the equipment indicated by Japanese Patent Application No. No. 307763 [eight to], and an image pick-up and display of a stereoscopic model can be performed to coincidence. In this invention, m is made into a large number, namely, optical-fiber length is lengthened, and since only the part equivalent to the die length can transmit a light figure, the solid image equipment with which an image pick-up, transmission, and a display were united as a result can be constituted.

[0029] This point is explained in detail below. Include-angle phii [as opposed to / when optical-fiber length fills (5) types, as it is shown in drawing 5 / the optical axis of the optical fiber of an incident ray] Include-angle phio to the optical-fiber optical axis of an output beam of light There is an equal property. Drawing 6 shows the incident ray and output beam of light at the time of arranging the plurality of such an optical fiber, as each end face is on the same flat surface about the optical fiber of one train.

The direction of the beam of light from the photographic subject 11 in an incidence end face is reproduced by the outgoing radiation end face so that it may be illustrated (12 is the image of the photographic subject which carried out image formation within the optical fiber). therefore, an outgoing radiation end-face side -- setting -- the same distance as the distance from an incidence edge to a photographic subject -- and a reconstruction image is acquired in the same magnitude as a photographic subject. In fact, it is arranged as two or more optical fibers explained by drawing 2 .

[0030] Other examples of this invention are shown in drawing 7 . This example is [0031] of the optical fiber which constitutes solid image equipment.

[Equation 6]

$$\theta = \frac{\pi}{2} + m\pi \qquad (6)$$

[0032] When parallel light inputs into optical-fiber 10A so that it may be shown in **********, i.e., drawing 7 , by inserting the expansion optical system 13 in the field which carries out image formation within this optical fiber shows that the magnitude of a playback stereoscopic model is expandable compared with a photographic subject. In this case, as optical fiber 10B of the side which displays the expanded stereoscopic model, the optical fiber of a path according to a scaling factor is used to optical-fiber 10A of an input side. If it replaces with the expansion optical system 13 and contraction optical system is inserted, a playback stereoscopic model is reducible. In this case, the optical fiber of a path smaller than optical-fiber 10A of an input side is used as optical-fiber 10B for a display. As expansion optical system and contraction optical system, there is a fiber optic plate (Hamamatsu Photonics, Inc. make) etc. The sum of the die length of the whole optical fiber of solid image equipment, i.e., the die length of optical-fiber 10A of an input side, and the die length of optical-fiber 10B by the side of a display needs to fill (5) types. Moreover, for convenience, although only one optical fiber was shown in drawing 7 , respectively as an optical fiber by the side of an input side and a display, it is respectively natural [the optical fiber by the side of an input side, and transmission / display] to consist of the aggregate of two or more optical fibers the same with having explained [of explanation] in drawing 2 . Moreover, a stereoscopic model can be rotated if the optical system (for example, the U.S.: INCOM shrine make) which rotates the image which carried out image formation is inserted in the location which inserts expansion optical system and contraction optical system.

[0033] Furthermore, multiplication of the brightness of a display image can be carried out, or the fall of the brightness by transmission loss can be compensated with

inserting optical multiplication equipments, such as an image intensifier, in the same location.

[0034]

[Effect of the Invention] As explained above, according to this invention, it can transmit with IP method covering a long distance, without [without it enlarges the scale of an optical transmission line for a solid image, and] changing light into an electrical signal. Furthermore, if an optical fiber is manufactured so that it can be crooked, it will also become possible to crook the transmission line of the solid image of this invention. Moreover, a stereoscopic model can also be expanded, reduced or rotated by inserting expansion optical system, contraction optical system, or rotation optical system in the specific location of the optical fiber which constitutes the solid image equipment of this invention. Furthermore, multiplication of the brightness of a display image can be carried out, or the fall of the brightness by transmission loss can be compensated with inserting an optical multiplication component. Therefore, the solid image equipment by this invention is applicable as the endoscope which offers a solid image, a bore scope, etc.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is drawing explaining the die length of the optical fiber used for this invention.

[Drawing 2] It is the typical perspective view showing the solid image equipment by this invention.

[Drawing 3] It is drawing showing the principle of operation of the optical fiber used for this invention.

[Drawing 4] It is drawing showing actuation of the optical fiber indicated by Japanese Patent Application No. No. 307763 [eight to].

[Drawing 5] It is drawing showing the close outgoing radiation beam of light of the optical fiber used for this invention.

[Drawing 6] It is the principle Fig. showing that a playback solid image is obtained by the solid image equipment by this invention.

[Drawing 7] It is drawing showing the configuration of the example to which a playback stereoscopic model is expanded.

[Drawing 8] It is the explanatory view of the conventional IP method.

[Drawing 9] It is drawing showing the situation near [in drawing 8] the lens.

[Description of Notations]

1 Photographic Subject

2 Convex Lens Group

21 22, ..., 2N Convex Lens

3 Photographic Film

31 32, ..., 3N Photoed Image

10, 10A, 10B Optical fiber

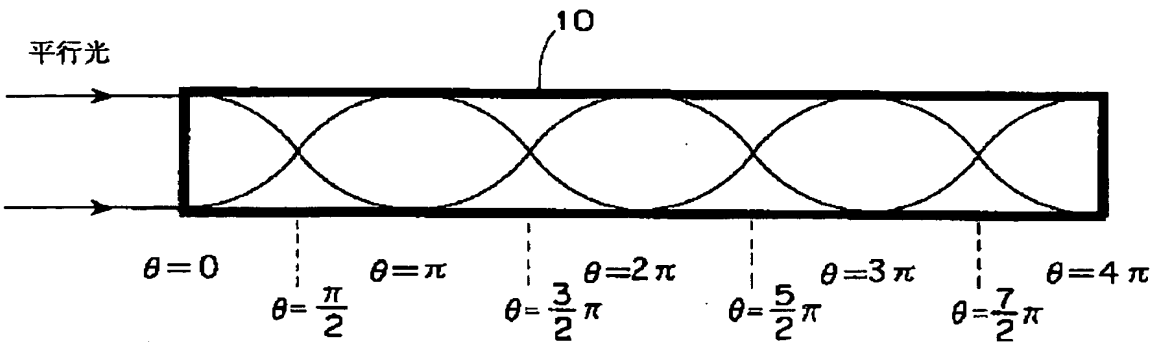
11 Photographic Subject

12 Image of Photographic Subject Which Carried Out Image Formation into Optical Fiber

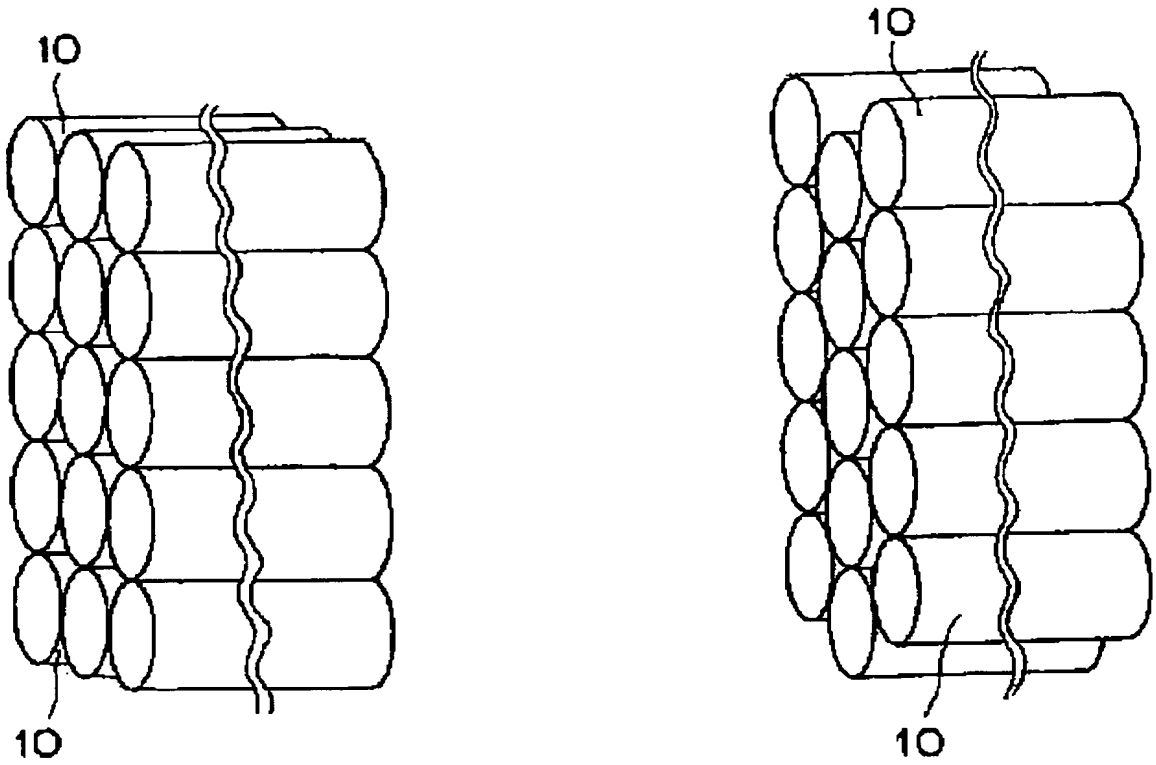
13 Expansion Optical System

DRAWINGS

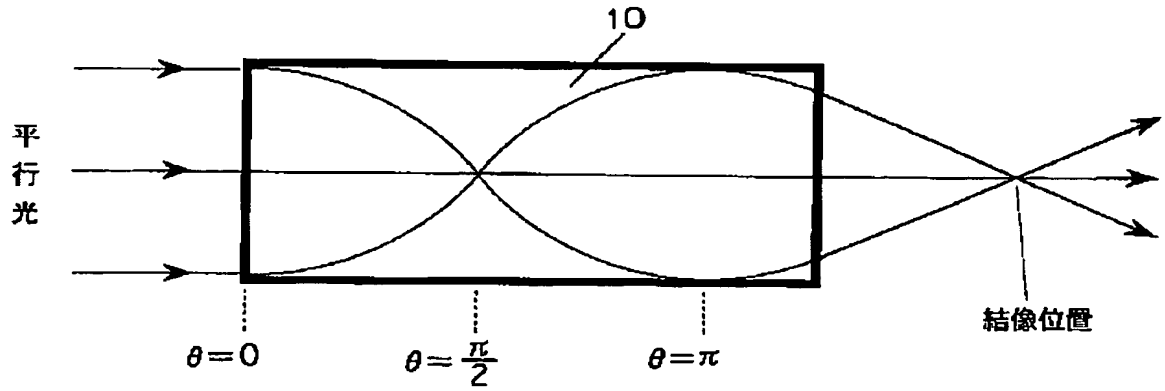
[Drawing 1]



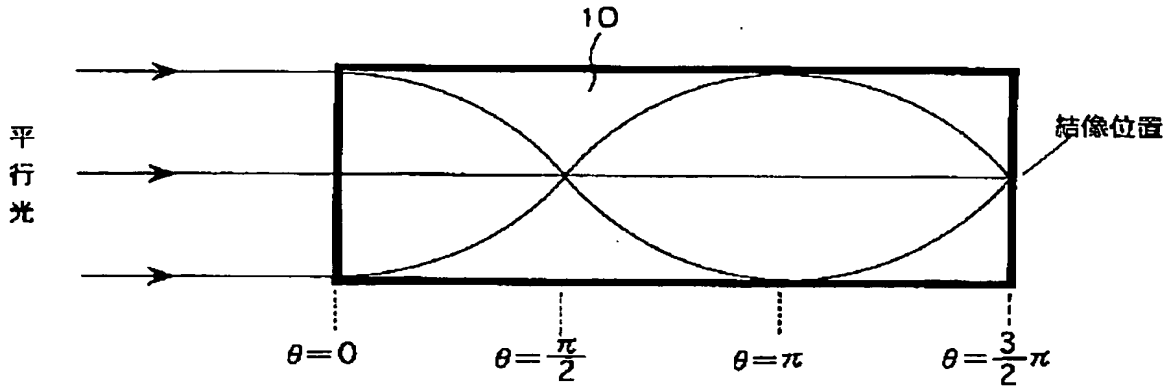
[Drawing 2]



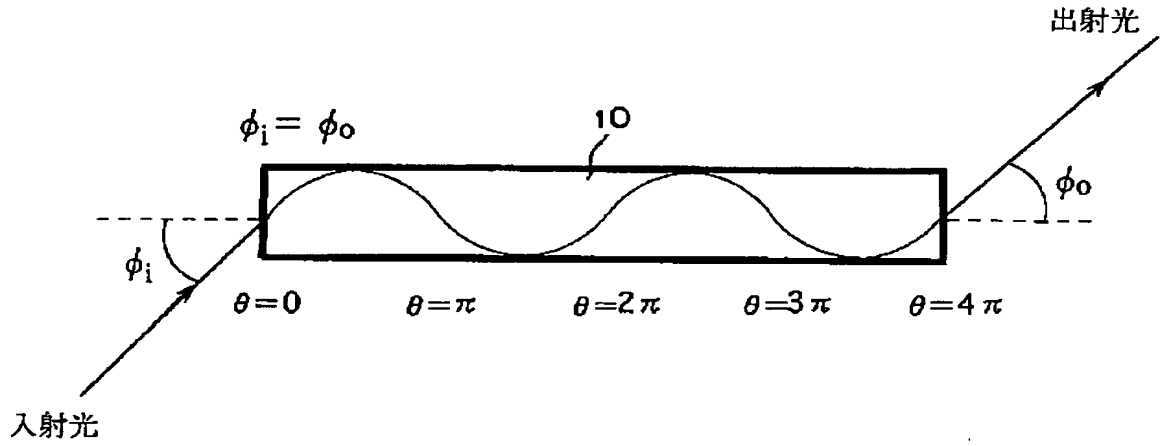
[Drawing 3]



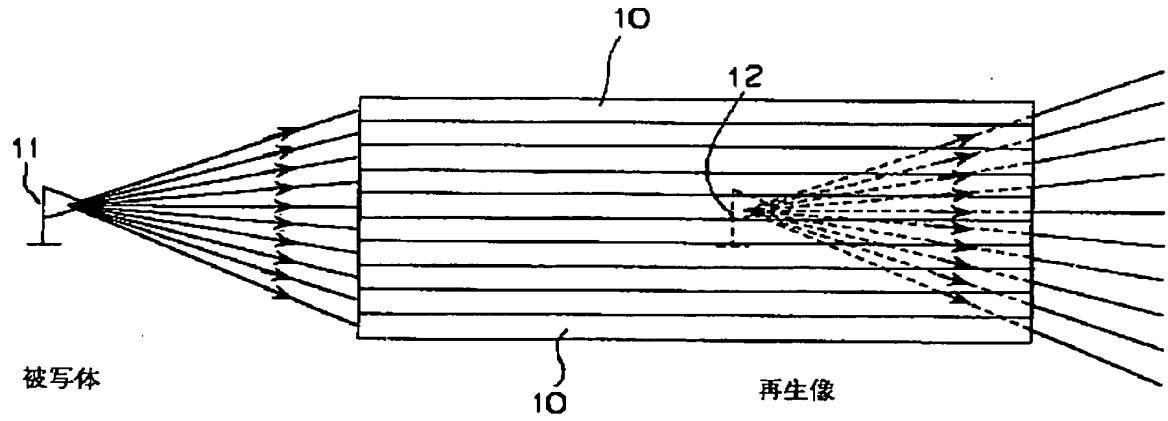
[Drawing 4]



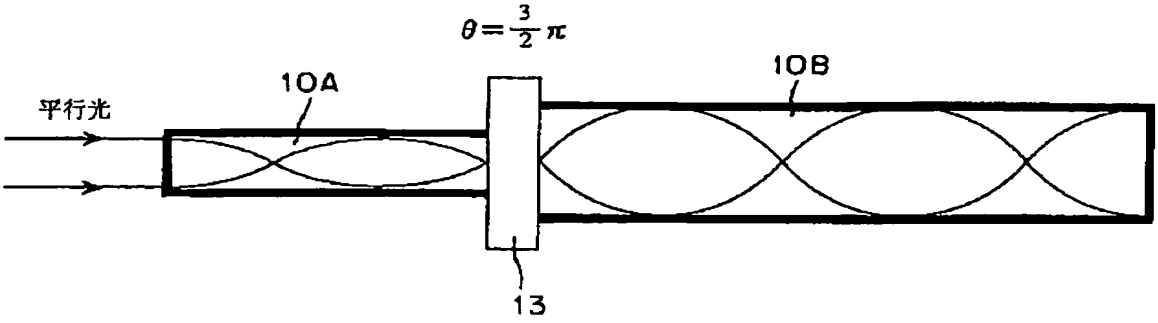
[Drawing 5]



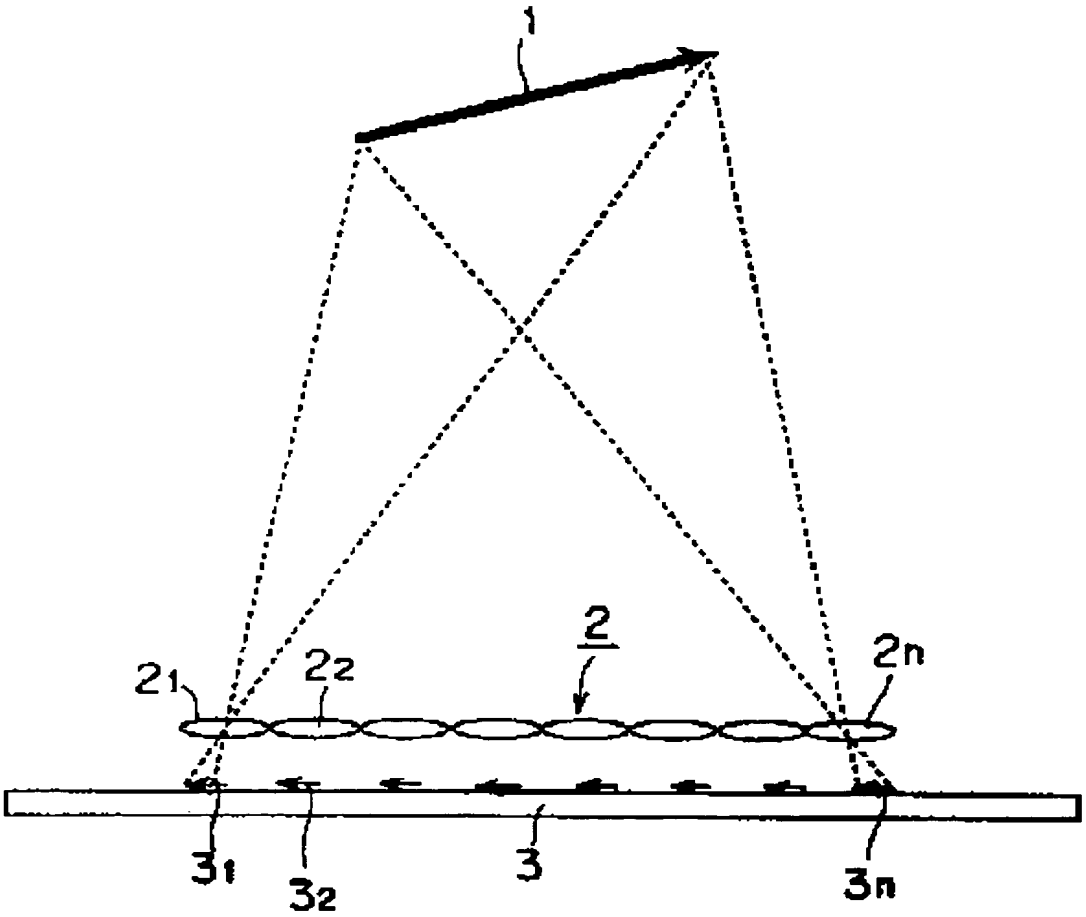
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Drawing 9]